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UTILITY APPLICATION FOR UNITED STATES PATENT
FOR
SERVER LOAD BALANCEING APPARATUS AND METHOD USING MPLS SESSION

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TITLE OF THE INVENTION

SERVER LOAD BALANCING APPARATUS AND METHOD USING MPLS SESSION

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BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to a load balancing apparatus and method, and more particularly to a server load balancing apparatus and method using multi-protocol label switching session labels, which, when packets are transmitted from a plurality of clients to a plurality of servers through the Internet, distributes loads among the servers by attaching the multi-protocol label switching session labels to the headers of the packets in front of the servers and determining a server for connection using session label information.

20 **Description of the Prior Art**

As various Internet-based multimedia services and e-commerce have been popularized, a plurality of web servers constitutes a server farm having a cluster form, and a server load balancing apparatus is generally located in front of the 25 server farm.

The server load balancing apparatus located in front of the servers to balance service or content requests from clients analyzes the information of packets received from the

clients and distributes the requests among the servers using various load balancing algorithms. In this case, the continuation of a session should be maintained.

For this purpose, a conventional load balancing apparatus analyzes session information, such as Internet Protocol (IP) address information, transmission Control Protocol (TCP)/User Datagram Protocol (UDP) port numbers, hyper text transfer protocol (http) information and cookie information, by analyzing the information of all packets ranging from a second layer to a seventh layer. If a new session is created, the server load balancing apparatus assigns a server to the new session using a server load balancing algorithm, and stores the information in a session management table. That is, all the packets undergo a process of determining which server the packet is transmitted to through a session information analysis or a session management table search.

However, the conventional load balancing apparatus requires additional complicated software processes of comparing and analyzing the header information of all packets ranging from a second layer to a seventh layer, thus reducing the performance of the loading balancing apparatus.

Another important function of the conventional load balancing apparatus is the function of converting the IP addresses of the servers into a virtual IP address. That is, when the clients connect with the servers, the clients use information about the virtual IP address of the server load balancing apparatus rather than the actual IP addresses of the servers, so that the server load balancing apparatus performs

the function of converting the IP addresses of the actual servers into the virtual IP address of the server load balancing apparatus while all packets are exchanged between the clients and the servers. As a result, this is
5 advantageous in that the IP addresses of the actual servers are not disclosed to the public, so that the servers are protected from hacking and changes in the construction information of the actual server farm do not affect the clients.

10 However, the conventional load balancing apparatus is problematic in that it should perform additional processes of intercepting all the packets and changing destination or source IP addresses information from the IP addresses of the actual servers to the virtual IP address of the server load
15 balancing apparatus.

U.S. Pat. No. 6,587,866 B1 entitled "Method for distributing packets to server nodes using network client affinity and packet distribution table" discloses a method of distributing packets among servers in a server farm. U.S.
20 pat. No. 6,601,084 B1 entitled "Dynamic load balancer for multiple network servers" provides a method and system for monitoring the loads of servers and distributing packets to a server having the lowest load when a load balancing system located in front of a server farm consisting of a plurality of
25 servers distributes packets among the servers. However, the preceding patents still have the problems of the prior art, and do not reduce processing overhead caused while analyzing the header information of all the packets for the load

balancing.

SUMMARY OF THE INVENTION

5 The present invention provides a server load balancing apparatus and method in a Multi-Protocol Label Switching (MPLS)-based network, which, when a plurality of clients are connected to a plurality of servers through the server load balancing apparatus, attaches the session labels to the
10 headers of packets whose session analysis is completed, and allows the server load balancing apparatus to determine a server for connection using only session label information, so that the load balancing apparatus does not perform a complicated process of analyzing all the packets and a
15 function of converting the IP addresses of actual servers into the virtual IP address of the load balancing apparatus is excluded, thus considerably simplifying the process of the load balancing apparatus and, therefore, improving the performance of the load balancing apparatus.

20 In order to accomplish the above object, the present invention provides a server load balancing apparatus using MPLS session labels, the server load balancing apparatus being located in front of a plurality of servers connected to a plurality of clients through the Internet, analyzing requests
25 from the clients and distributing the requests among the servers, comprising a packet analyzing unit for inspecting whether a session label has been attached to a received packet, analyzing header information of the received packet to

learn session information, and attaching a session label to a header of the received packet; a load balancing processing unit for assigning a server to a session of the received packet without the session label attached in view of load
5 balancing according to a result of the inspection of the packet analyzing unit; a session label switching unit for hardware-switching the received packet with the session label attached using only the session label information without a packet analysis process or server assignment process according
10 to a result of the inspection of the packet analyzing unit; a session managing unit for managing and maintaining relevant information and states of sessions requested by the clients; and a session label managing unit for assigning the session label, and withdrawing and managing session label not in use.

15 In addition, the present invention provides a server load balancing method using MPLS session labels, in which a plurality of clients are connected to a plurality of servers, and a server load balancing apparatus located in front of the plurality of the servers analyzes requests from the clients
20 and distributes loads among the servers, comprising a first step of the server load balancing apparatus recognizing a new session by analyzing a header of a received packet and assigning a C2S session label when the client requests service from the server through the server load balancing apparatus; a
25 second step of the server load balancing apparatus assigning a specific server for servicing the session in view of load balancing, attaching the assigned C2S session label to the received packet, and transmitting the received packet with the

C2S session label attached to the server; a third step of the server having received the packet with the C2S session attached automatically assigning an S2C session label, that is, an opposite direction session label, with reference to a 5 value of a session label of the received packet; a forth step of the server processing the service request from the client, attaching the assigned S2C session label to the packet according to a result of the processing, and transmitting the received packet with the S2C session label to the server load 10 balancing apparatus; a fifth step of the server load balancing apparatus having received the packet with the S2C session label attached from the server label switching the received packet to the client using the value of the session label; a sixth step of the client having received the received packet 15 with the S2C session label attached automatically assigning the C2S session label, that is, an opposite direction session label to the received packet, with reference to the value of the session label of the received packet; a seventh step of the client attaching the packet with the assigned C2S session 20 label attached and transmitting the packet with the assigned C2S session label to the server load balancing apparatus when the client transmits the packet to a destination server; and an eighth step of the server load balancing apparatus having received the packet with C2S session label attached from the 25 client label switching the packet with C2S session label attached to the destination server; wherein the server load balancing apparatus determines the server for connection using information of the session label with respect to the packet

with the session label attached.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The above and other objects, features and advantages of
the present invention will be more clearly understood from the
following detailed description taken in conjunction with the
accompanying drawings, in which:

10 FIG. 1 is a view showing an example of the configuration
of a service network to which a server load balancing
apparatus according to the present invention is applied;

15 FIG. 2 is a function block diagram of the server load
balancing apparatus according to an embodiment of the present
invention;

20 FIG. 3 is a view showing an example of a session table of
the server load balancing apparatus, according to the present
invention;

25 FIG. 4 is a view showing a label switching configuration
of a server load balancing apparatus according to an
embodiment of the present invention;

30 FIG. 5 is a view showing an example of a label switching
table according to the present invention;

35 FIG. 6 is a flowchart showing a process of performing
load balancing according to an embodiment of the present
invention;

40 FIG. 7 is a view showing an example of the assignment of
values of bi-directional session labels in the process of the
load balancing, according to the present invention; and

FIG. 8 is a configuration diagram of a packet in which a MPLS session label is encapsulated according to the present invention.

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DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference now should be made to the drawings, in which the same reference numerals are used throughout the different drawings to designate the same or similar components.

10 FIG. 1 is a view showing an example of the configuration of a service network to which a server load balancing apparatus 103 according to the present invention is applied. As shown in FIG. 1, in the configuration of the service network for providing a server connection service to which the 15 present invention is applied, a plurality of clients 101 are connected to a server farm 105 composed of a plurality of servers through the Internet 102, and the server load balancing apparatus 103 according to the present invention is located in front of the server farm 105, analyzes requests 20 from the clients 101 and distributes the requests among the servers 105. The reference numeral 104 designates a web/media server cluster.

FIG. 2 is a function block diagram showing a server load balancing apparatus 200 according to an embodiment of the 25 present invention. Referring to FIG. 2, the server load balancing apparatus 200 of the embodiment includes a packet analyzing unit 210, a load balancing processing unit 220, a session label switching unit 230, a session managing unit 240

and a session label managing unit 250. Additionally, the server load balancing apparatus 200 exchanges packets having attached session labels or general IP packets with servers or an IP network 201.

5 The packet analyzing unit 210 includes a session label inspecting function unit 212 for inspecting whether a session label has been attached to a received packet, a packet contents analyzing function unit 211 for analyzing header information ranging from the third to seventh layers of the
10 packet, and a session label attaching function unit 213 for attaching the assigned session label in case of need. The session label inspecting function unit 212 inspects whether the session label has been attached to the received packet, and, thereafter, transmits the received packet to the session
15 label switching unit 230 if the session label has been attached to the received packet. If the session label has not been attached to the received packet, the packet is the packet of a new session, so that the session label inspecting function unit 212 transmits the packet of the new session to
20 the packet contents analyzing function unit 211 to analyze the session information thereof. The packet contents analyzing function unit 211 analyzes the session information by analyzing header information ranging from the third to seventh layers of the packet, and compares the analyzed information
25 with the contents of a session table 242 managed by the session managing unit 240. If, as a result of the comparison, a session of the received packet is new, the received packet is transmitted to the load balancing processing unit 220 to be

assigned a service server. If the session of the received packet is not new, the received packet is transmitted to a relevant server with reference to the session table 242 because the client does not support the session label 5 function. The session label attaching function unit 213 performs a function of attaching a session label to a packet that will be transmitted from a client to a server or from a server to a client.

The load balancing processing unit 220 assigns a server 10 to the new session in view of load balancing. A load balancing algorithm function unit 222 determines a load balancing server using various algorithms, such as a Round Robin Method, the assignment of a server in view of a minimally connected server and weights, and an algorithm in 15 view of a response time from the server. In this case, a server configuration/state managing function unit 221 performs functions of monitoring the states of servers in real time and conducting configuration management to reflect the configuration/states of the servers. Additionally, a service 20 acceptance control function unit 223 refuses the provision of a service not to accept a service request when a reduction in service quality of the existing sessions in service may occur due to a new session. The service acceptance control function is advantageous in that the reduction of performance may be 25 prevented because the service acceptance control function inspects only the packets of new sessions, or packets without session labels attached, and does not inspect the packets of existing sessions with the session labels attached.

The session label switching unit 230 is a module for hardware-switching packets with session labels attached at high speed without analyzing the packets or assigning a server. A session label-based switching unit 231 performs 5 label switching with reference to the label switching table 232, which is one of core functions of the load balancing apparatus.

The session managing unit 240 is a module for maintaining and managing session information and session states requested 10 by clients. A session managing function unit 241 functions to recognize the start, determination and interruption of a session and to add, delete and change relevant information in the session table 242. The session table 242 is referred to by the packet analyzing unit 210 or the load balancing 15 processing unit 220 to perform functions thereof.

The session label managing unit 250 is a module for managing the session labels. A session label managing function unit 251 assigns session labels needed when sessions are added or deleted, and withdraws and controls session 20 labels not in use. The value of the session label may be assigned to each server or the server load balancing apparatus.

FIG. 3 is a view showing an example of a session table of the server load balancing apparatus according to the present 25 invention. Referring to FIG. 3, the session table 242 includes session identifiers 31, protocols 32 indicating the protocol characteristics of sessions, source and destination IP addresses 33 and 34, source and destination port numbers 35

and 36, bi-directional session labels values 37, and assigned server identifiers 38. In the session table shown in FIG. 3, C2S and S2C session labels indicate a client-to-server session label and a server-to-client session label, respectively.

FIG. 4 is a view showing a label switching configuration of a server load balancing apparatus 300 according to an embodiment of the present invention. Referring to FIG. 4, the server load balancing apparatus 300 of the present embodiment includes a main processor 316, a plurality of line cards (LC) 311 to 314, a switch 315, and ports 317 and 318. An IP network 304 and a plurality of servers 303 are connected to the server load balancing apparatus 300 through the ports 317 and 318. It is assumed that, if a client A 302 sets up a session together with a server 4 303 and receives services while the client A 302 is connected to the server load balancing apparatus 300 through the port 1 317 of the line card 1 311 of the server load balancing apparatus 300 and the server 4 303 is connected to the server load balancing apparatus 300 through the port 2 318 of the line card 4 314, bi-directional session labels are 1001 and 1002, respectively. In this case, the label switching table 232, as shown in FIG. 5, includes the label values of connected sessions 51, and the line card and port information of input and output ports 52 and 53.

FIG. 6 is a flowchart showing a process of performing load balancing according to an embodiment of the present invention, which shows a process of performing load balancing in a service network for providing a server connection service

to which the present invention applied. In FIG. 6, the process of performing load balancing in the service network shown in FIG. 1 is described as an example, and the components having the same constructions and functions are assigned the 5 same reference numerals. As shown in FIG. 6, a plurality of clients 101 are connected to a server farm 105 through the Internet 102. A server load balancing apparatus 103 of the present invention is located in front of the servers 105, thus analyzing requests from the clients 101 and distributing the 10 requests among the servers 105. A service is performed as described below.

If one of the clients 101 requests a service, such as a web connection or e-commerce, the service request is transmitted to the server load balancing apparatus 103 having 15 a virtual IP address through a Domain Name Server (DNS) at step S111. The server load balancing apparatus 103 analyzes a received packet. That is, the server load balancing apparatus 103 learns session information by analyzing the IP address, TCP/UDP port numbers, and http information of the header of 20 the received packet, and cookie information in case of e-commerce at step S112. When the session information of the received packet is learned, a server (for example, web server 105) for providing a service to the session is determined using server load balancing algorithms at step S113. 25 Furthermore, a session label is assigned to be used for the session at step S114. In this case, a Client-To-Server (C2S) session label is assigned as assigned session label, and the value of the assigned session label is an odd number.

If the server for providing the service and the value of the session label are determined, the server load balancing apparatus 103 of the present invention attaches the C2S session label to the header of the received packet, and 5 transmits the received packet to the server for providing the service at step S115. In this case, a MPLS label encapsulation construction is applied to the method of attaching the session label. The server 105 having received the packet with the C2S session label attached automatically 10 assigns an opposite directional session label with reference to the value of the received session label at step S116. In this case, a S2C session label is assigned as the assigned session label, and the value of the assigned session label is an even number that is obtained by adding 1 to the C2S session 15 label.

The server 105 processes the service or content request from the client 101 while maintaining the session and session label information in the system at step S117. The processed result or response message is transmitted to the client 101. 20 At the time, the processed result or response message is transmitted to the server load balancing apparatus 103 with the S2C label attached, and the virtual IP address of the server load balancing apparatus 103 attached as a source IP address at step S118. An even number obtained by adding 1 to 25 the value of the C2S session label received from the server load balancing apparatus 103 is used as the value of the S2C session label.

When the server load balancing apparatus 103 receives the

packet with the S2C session label attached from the server 105, the server load balancing apparatus 103 performs fast hardware label switching according to the value of the session label through an interface connected to the client 101 at step 5 S119. The packet with the S2C session attached is transmitted to the client 101. In this case, the packet is transmitted by IP routing or MPLS label switching at step S120. In the case where the packet is transmitted by the MPLS label switching, a label for tunneling should be encapsulated in the form of a 10 first label in front of the session label. This label for tunneling functions between network apparatuses in the Internet without relation to the server load balancing apparatus 103, client 101 or server 105, and is not related to the distinctive construction of the present invention.

15 The client 101 having received the packet with the S2C session label attached determines the value of the C2S session label by subtracting 1 from the value of the S2C session label and automatically assigns the C2S session label in an opposite direction at step S121. When the client 101 exchanges 20 information in the same session while maintaining session information, the client 101 attaches the C2S session label to the packet and transmits the packet with the C2S session label attached to the server load balancing apparatus 103 at step S122. When the server load balancing apparatus 103 receives 25 the packet with the C2S session label attached from the client 101, the server load balancing apparatus 103 switches the packet to a destination server using only the value of the session label without various processes of analyzing the

header of the packet at step S123. The packet with the C2S label attached is transmitted to the destination server at step S124.

When the client 101 desires to discontinue the service or session, the discontinuation of the service or session is requested from the server load balancing apparatus 103 at step S125, and the client 101 deletes the session label information at step S126. The server load balancing apparatus 103 having received the service of the session request performs the discontinuation of the session at step S127, deletes relevant information in a session management table, and withdraws the bi-directional session labels at step S128. Additionally, when the server load balancing apparatus 103 informs the destination server of the discontinuation of the session at step S129, the destination server deletes the session information and the session label information at step S130.

In the above-described process of performing the service, at steps ranging from step S114 of assigning the session label to step S129 of discontinuing the session, the packet is transmitted with the session label attached.

FIG. 7 is a view showing an example of the assignment of the values of bi-directional session labels in the process of performing load balancing according to the present invention. For example, as shown in FIG. 7, when a session 1 is created, session information is analyzed, a destination server is determined using a load balancing algorithm, and the value of a session label is assigned. In this case, 1 is assigned as the value of the C2S session label, and 2 obtained by adding 1

to the assigned value of the C2S session label is automatically assigned as the value of an S2C session label.

The method of assigning session label values is advantageous in that, if bi-directional session labels are assigned by the server load balancing apparatus, the method allows the server and the client to automatically determine the value of an opposite directional label based on the value of a received session label without an additional session label assignment protocol functioning between the client and the server. The session label assigning management session label is processed by the session label managing function of the load balancing system.

FIG. 8 is a view showing the configuration of a packet in which a MPLS-based session label is encapsulated according to the present invention. Referring to FIG. 8, Real-Time Transport Protocol (RTP), TCP/UDP and IP headers are attached in front of a general payload. An MPLS session label header is composed of 32-bit header including a session label (20 bits), EXP (3 bits), TTL (8 bit) and S (1 bit). The EXP and TTL of the MPLS session label header are values defined in the MPLS, but are not used in the MPLS session label. The S bit is a value indicating whether a MPLS label is stacked, and is set to 0 because it is the lowest label of the session label. A MPLS top label is used when MPLS label switching is performed on the Internet, and is attached or removed between only backbone network apparatuses.

As described above, the server load balancing apparatus and method determine a server for connection using only

session label information without a complicated process of analyzing all the packets with the session label attached, so that the load balancing process may be considerably simplified.

5 According to the present invention, when Internet-based services, such as multimedia and e-commerce services, are provided to clients by a server farm composed of a plurality of servers, the load balancing system processes hardware label-switches packets with session labels attached to a
10 destination server using only session label information without the complicated analysis process of analyzing header information ranging from third to seventh layers of the packets with the session labels attached. Accordingly, the process of a conventional load balancing apparatus is
15 considerably simplified, thus improving the performance of the load balancing apparatus.

Furthermore, the server load balancing apparatus performs connection control using session label information, so that a function of converting the IP addresses of actual servers into
20 virtual IP information with respect to all packets, which is essentially required in the conventional load balancing system, is not undergone, thus simplifying the load balancing process.

Additionally, when it is determined whether a new session
25 is accepted, the server load balancing apparatus selectively applies the determination only to the packets without the session label attached, so that a reduction in the service quality of the packets of an existing session with the session

labels attached can be prevented.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.